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Matter under extreme conditions

August 30 – September 03, 2004

Brijuni, Croatia

Editor: S.D. Bosanac

NATO Advanced Research Workshop

Institut Rudjer Bošković
Zagreb, 2004

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Contents

1. Program

Monday, 30. August

8.45-9.00	**S. D. Bosanac** - Introductory remarks
Chairman: **G. Pichler**	
9.00-9.40	**T. W. Haensch:** From ultra-precise spectroscopy to attosecond physics
9.40-10.00	**discussion**
10.00-10.40	**G. Gerber:** Optimal control of molecular and electron dynamics by tailored femtosecond laser pulses
10.40-11.00	**discussion**
11.00-11.20	**coffee break**
11.20-12.00	**G. Meijer:** Manipulation of molecules with electric fields
12.00-12.20	LUNCH AND BEACH DISCUSSIONS
Chairman: **M. Martinis**	
17.30-18.10	**M. Inguscio:** Manipulation of BEC and degenerate Fermi gases with laser light
18.10-18.30	discussion
18.30-19.10	S. **D. Bosanac**: Charge in very strong electromagnetic field
19.10-19.30	discussion

21.00 Opening of poster session

Chairman: **L. Klasinc**

A. Šiber Helical structures in physics and biology: From atoms adsorbed on carbon nanotubes to microtubules and pineapples.
W. Christen Cluster-surface impact experiments
A. Graovac On discriminative properties of topological indices
V. Zlatić Thermoelectric properties of strongly correlated systems close to the metal-insulator boundary
M. Ramek Colour perceptions problems in connection with computer presentations like web pages
S. Tomić Changing enzyme specificity
V.Mikuta-Martinis Charge and isospin fluctuations in high energy pp-collisions
D. Desnica-Franković Small is different: size related luminescence
U. V. Desnica From atoms to nano-particles: changing the shape
Yunjie Xu Ab initio and spectroscopic studies of chiral interactions
I. Matanović Intramolecular Hydrogen bond in acetylacetone: infrared spectroscopy and tunneling dynamics
M. Martinis Quantum Horizons and Spacetime Non-commutativity
M. Eckert-Maksić Synthesis of organometallic compounds under high pressure
D. Plavšić On Canonical Labeling of Proteome Maps
R. Beuc Spectroscopy of Cold Cs_2 Molecules on Helium Nanodroplets
I. Ljubić CASSCF/CASPT2 Study of Mechanism and Kinetics of the Gas-phase Ozone Additions to Ethene, Fluoroethene and Chloroethene
L. Klasinc Gas-Phase Reaction of Nb+ and Fe+ with Perfluoronaphthalene and Perfluoroanthracene

Tuesday, 31. August

Chairman: **A. Sabljić**

9.00-9.40	**D. Jouvenot:** From chemical topology to machines and motors at the molecular level
9.40-10.00	discussion
10.00-10.40	**W. Klemperer:** Making and breaking weak bonds: Spectroscopic studies of intermolecular interactions
10.40-11.00	discussion
11.00-11.20	coffee break
11.20-11.40	**W. Jaeger:** Spectroscopic studies of quantum solvation with Helium atoms
11.40-11.50	discussion
11.50-12.10	**P. R. Bunker** and **P.Jensen:** Molecules in high angular momentum states
12.10-12.20	discussion

LUNCH AND BEACH DISCUSSIONS

Chairman: **B. Friedrich**

17.00-17.40	**E. Polzik:** Entangled matter
17.40-18.00	discussion
18.00-18.40	**P. Zoller:** Quantum information and condensed matter physics with cold atoms
18.40-19.00	discussion
19.00-19.40	**B. Friedrich:** The Stark accelerator/decelerator for molecules viewed as a biased pendulum
19.40-20.00	discussion

Chairman: **S. D. Bosanac**

21.00	**H. Kroto:** Can Art and Science Really Mix?

Wednesday, 1. September

Chairman: **T. Živković**

9.00-9.40	**B. Tarter**: High energy density science on the National Ignition Facility
9.40-10.00	discussion
10.00-10.40	**K. Lackner:** Magnetically confined termonuclear grade plasmas.
10.40-11.00	discussion
11.00-11.20	coffee break
11.20-12.00	**T. Ebbesen:** Squeezing light through small holes: Fundamentals and applications
12.00-12.20	discussion

PICNIC

Chairman:**S. Leach**

21.00	**K. Nealson**: Extremes of life on Earth: Can they tell us about the possibility of life elsewhere?

Thursday, 2. September

Chairman: **I. Picek**

9.00-9.40	**P. Biermann**: The origin and physics of the highest energy cosmic rays
9.40-10.00	discussion
10.00-10.40	**E. Copeland:** Attempts to explain the nature of Dark Energy-how desperate can we get?
10.40-11.00	discussion
11.00-11.20	coffee break
11.20-12.00	**T. Vachaspati:** Cosmic problems for condensed matter experiment12.00-12.20
12.00-12.20	discussion

LUNCH AND BEACH DISCUSSIONS

Chairman: **P. Jensen**

17.00-17.40	**U. Landman**: Small is different: self-selection, self-organization and symmetry breaking at nano-scale and under extreme confinement
17.40-18.00	discussion
18.00-18.40	**R. Hemley Materials:** Under Pressure: New Findings and Phenomena
18.40-19.00	discussion
20.30	conference dinner

Friday, 3. September

Chairman: **M. Heggie**

9.00-9.40	**S. Berry:** Atomic clusters and bulk: Implications of voids, especially at very high pressures
9.40-10.00	discussion
10.00-10.40	**S. Leach:** Are local and 1 Kpc distant Cosmic Background Radiation Temperatures the same?
10.40-11.00	discussion
11.00-11.20	coffee break
11.20-12.00	**M. Harwit**: Summary of the Conference
12.00-12.20	discussion

2. Abstracts

CONICAL EMISSION IN DENSE CESIUM VAPOR

Damir AUMILER, Ticijana BAN, Goran PICHLER
Institute of Physics, Zagreb, Croatia

When strong, near-resonant laser light propagates through gaseous medium, conical emission is observed. The effect was originally observed in potassium vapor [1] and has been the subject of intense theoretical and experimental investigations ever since. Continuous wave (cw) and pulsed nanosecond (ns) conical emission was observed in sodium [2], potassium, barium [3], cesium [4], calcium [5] and strontium [6] vapor. Picosecond (ps) and femtosecond (fs) conical emission was also observed in glasses [7].

As a physical phenomenon of strong light field interaction with nonlinear medium, conical emission involves a whole range of classical nonlinear-optical effects, such as self-focusing, self-phase modulation, supercontinuum generation, four-wave mixing, stimulated Raman scattering, multiphoton ionization and many others, which add up together to produce emission in the form of a cone of broad spectra.

We present experimental results of femtosecond laser generated conical emission in dense cesium vapor. The problem of interplay of different nonlinear-optical effects leading to the formation of the conical emission is accessed through the measurements of cone emission angle dependence on laser wavelength, laser power and vapor optical characteristics.

The results show that the maximum cone angle is observed at approximately 750 nm laser wavelength, which is very close to the maximum of the Cs_2 X-B absorption band. This is rather surprising since the conical emission is usually connected to atomic resonances. However, our findings suggest the molecular origin of the conical emission.

References:

[1] D. Grischkowsky, Phys. Rev. Lett. **24**, 866 (1970).
[2] A. Dreischuh *et al.*, J. Opt. Soc. Am B **15**, 34 (1998).
[3] W. Chalupczak, W. Gawlik, J. Zachorowski, Phys. Rev. A **49**, 4895 (1994).
[4] M. Ter-Mikaelian, G. Torossian, G. Grigoryan, Opt. Commun. **119**, 56 (1995).
[5] M. Fernandez-Guasti, J. Hernandez-Pozos, E. Haro-Poniatowski, L. Julio-Sanchez, Opt. Commun. **108**, 367 (1994).
[6] R. Hart, L. You, A. Gallagher, J. Cooper, Opt. Commun. **111**, 331 (1994).
[7] R. Alfano, S. Shapiro, Phys. Rev. Lett. **24**, 584 (1970).

BACKWARD FLUORESCENCE FROM DENSE CESIUM VAPOR INDEUCED BY Ti:Sa FEMTOSECOND LASER

Ticijana BAN, Damir AUMILER and Goran PICHLER
Institute of Physics, Zagreb, Croatia

At very high cesium densities almost no light can be transmitted. However, backward fluorescence excited by the laser entering the vapor can be readily collected and spectrally analyzed. In the past c.w. and nanosecond lasers have been used for such observations. We were interested in the excitation of the backward fluorescence by a Ti:Sa femtosecond laser oscillator. The tuning range was 700-850 nm and the temperature of an all-sapphire cell was in the 400-600 ^{o}C range.

The spectrum was resolved between 280 and 1100 nm with numerous well known spectral features. However, a few new satellite bands especially in the infrared region revealed that two potential curves of 0_g^- symmetry made two avoided crossings. This interpretation of satellite bands in the near infrared spectral region has interesting connection with cesium ultracold molecule formation [1].

The rest of the visible spectrum consisted of numerous atomic emission lines and a few of molecular origin. We were also interested to compare obtained backward LIF with high pressure pulsed Cs lamp spectrum [2], which may serve in further development of cesium discharge lamp.

However, when the excitation wavelength approached 750 nm, we observed entirely different spectrum with irregular oscillations. Since this wavelength also correlates with the maximum cone angle (see next poster), we believe that it might be the consequence of self-phase modulation effect.

References:

[1] C. M. Dion, O. Dulieu, D. Comparat, W. de Souza Melo, N. Vanhaecke, P. Pillet, R. Beuc, S. Milošević, and G. Pichler, Photoionization and detection of ultracold Cs_2 molecules through diffuse bands, *European Physical Journal D*, **18** (2001) 365-370.
[2] G. Pichler, V. Živčec, R. Beuc, Ž. Mrzljak, T. Ban, H. Skenderović, K. Günther and J. Liu, UV, visble and IR spectrum of the Cs high pressure lamp, *Physica Scripta*, **T105** (2003) 98-100.

ATOMIC CLUSTERS AND BULK: IMPLICATIONS OF VOIDS, ESPECIALLY AT VERY HIGH PRESSURES

R. Stephen BERRY
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Clusters and solids composed of atoms lend themselves to a simplifying treatment in which vibrational and configurational energies and entropies are separated, and vacancies or their relaxed forms which we call "voids" become useful, nonconserved elements of the structure of a system. The diffusion of voids provides a useful way to interpret the growth of a nucleating phase, e.g. a solid growing in a liquid or the reverse. At pressures high enough that the interparticle forces are repulsive (but below pressures at which insulators become metallic), the void concept leads to the conclusion that at nonzero temperatures, the most stable form of an atomic cluster or bulk solid is not a regular crystalline one, but rather one with a significant degree of disorder, particularly in the form of voids. The nature of the phase change between regular crystal and disordered system is not known, and might be either first-order or second-order. Both currently seem physically plausible.

THE ORIGIN AND PHYSICS OF THE HIGHEST ENERGY COSMIC RAYS

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We will describe the latest efforts to understand the origin of the highest energy cosmic rays, 1) the traces of the last gamma ray burst in our Galaxy, 2) the black hole activities in the nearby universe, 3) the possible origin of other particles in the distant universe.
1) We propose that the excess flux of particle events of energy near 10^{18} eV from the direction of the Galactic Center region is due to the production of cosmic rays by the last few Gamma Ray Bursts in our Galaxy. The basic idea is that protons get accelerated inside Gamma Ray Bursts, then get ejected as neutrons, decay and so turn back into protons, meander around the inner Galaxy for some time, and then interact again, turning back to neutrons to be observed at our distance from the Galactic Center region, where most star formation is happening in our Galaxy. We demonstrate that this suggestion leads to a successful interpretation of the data, within the uncertainties of cosmic ray transport time scales in the inner Galaxy, and in conjunction with many arguments in the literature. This work was done in a collaboration with Gustavo Medina Tanco (Univ. Sao Paolo), Ralph Engel (FZ Karlsruhe), Giovanna Pugliese (ESO Munich). The paper has been published in ApJ Letters, and is available on astro-ph/0401150.
2) In the picture for the activity of relativistic jets (dubbed jet-disk symbiosis picture) we model the hadronic part of the energetic particle population, maximum particle energy and maximum particle flux. Using these simple constraints derived from a well tested model for the activity of black holes, we can sum all the cosmic ray contributions possible from the cosmologically nearby black holes. We find that at the highest energy the radio galaxy M87 dominates, at somewhat lower energies (around 20 EeV) the radio galaxy Cen A dominates, and at still lower energies the Seyfert galaxy NGC1068 contributes. However, since the maximum particle energy is quite low, a few EeV or even less for most sources, the sum over many weak sources does not contribute significantly around even 10 EeV, contrary to a first simple expectation. Introducing then a simple model for a turbulent magnetic halo wind of our Galaxy, akin to the Solar wind in some aspects, we can simulate readily all presently observed properties of the highest energy cosmic rays, such as spectrum and sky distribution. This would give a strong handle on the energetics of all radio galaxies that contribute to the overall energetics in clusters and filaments of galaxies. The conclusion is confirmed that this activity injects noticeable power into clusters, filaments and sheets in the cosmological galaxy distribution. The latest stage of this work was done with Alex Curutiu, Ioana Maris and Oana Tascau (all Bukarest, Romania), Ralph Engel (FZ Karlsruhe), and Ralf Ulrich (Bonn). Important earlier work was with Heino Falcke (Nijmegen, and Dwingeloo, Netherlands), and Sera Markoff (MIT, Cambridge, MA, USA).
3) For more distant possible sources many candidates exist, such as the decay of topological defects, or dark matter particles; however, also the acceleration of protons to high energy, and their subsequent interaction to produce other hypothetical particles in ``beam dump quasars", common in merger remnant galaxies after the two central black holes themselves with a spin-flip of the major black hole, allowing the relativistic jet to poke through dense coulds, such as probably in 3C147. Then other, as

yet unknown particles, could be produced, that do not interact with electromagnetic fields, but should interact in the Earth's atmosphere just as a hadron. This leads to some interesting speculations on possible sources. We show, again using our jet-disk symbiosis picture, that the sources thus very speculatively identified, could in principle produce the particle energy and particle flux required. This part of the work was done with Ioana Maris.

CHARGE IN VERY STRONG ELECTROMAGNETIC FIELD

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One of the most mysterious phenomenons of nature is annihilation/creation of charges. The process of annihilation is intimately connected with the strong EM field because it happens at very short inter charge distances. Likewise creation of charges happens under the impact of very strong fields (collision of relativistic charges). Few estimates of strong EM field are given, and three possible criteria are reviewed that distinguish the strong from the weak one. One in particular is important and it is based on distinguishing quantum and classical effects. Possible basis for describing the phenomenon of annihilation is strict formulation of the field reaction force, because it gives the correct energy balance between radiated energy in dynamics of charges at the expense of their mechanical energy. It is shown in classical dynamics that the latter also includes the energy of the rest mass of the charges.

PARTIALLY COHERENT WAVES IN NONLINEAR PERIODIC LATTICES

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We present recent developments regarding the problem of propagation of partially coherent waves in nonlinear periodic lattices. In particular, we will discuss Random-phase (incoherent) solitons in nonlinear periodic lattices and the evolution of the (Floquet-Bloch and Fourier) power spectra of partially coherent light in nonlinear lattices. Dynamics here depends mostly on the interplay between the statistical properties of the waves, and the lattice periodicity. The most important characteristic length-scales involved are the spatial correlation distance, which gives a length-scale at which there is still some correlation between the electric field amplitudes, and the lattice spacing. It will be shown that random phase solitons exist in such system when the intensity profiles, statistical (coherence) properties, and power spectra conform to the periodicity of the lattice. Furthermore, we will present a method for nonlinear Brillouin zone spectroscopy, which naturally arises from the specific properties of the nonlinear evolution of the power spectra in this system. While describing the systems mentioned above, we will explain the characteristic length-scales and time-scales involved, briefly explain the derivation of equations of motion from the underlying Maxwell equations, and extract the most interesting features of dynamics. In addition, we will briefly discuss the analogy between these optical systems governed by the Nonlinear Schroedinger type equation(s), and the systems of weakly interacting bosons, at low temperatures, in optically induced lattices.

MOLECULES IN HIGH ANGULAR MOMENTUM STATES

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Per JENSEN
Theoretische Chemie, Bergische Universitaeat, Wuppertal, Germany

Molecules in high angular momentum states are molecules in an extreme condition, and they are qualitatively changed by the centrifugal distortion and Coriolis coupling effects that occur. The rotational and vibrational dynamics are altered so that energy level clustering occurs, and as a result chiral states are induced in otherwise nonchiral molecules. For molecules that have electronic state degeneracy at linear configurations, i.e. the Renner efect, there can be a severe modification of the potential energy surfaces that define the structure and dynamics of the molecule. Strong, rather than weak, bonds can be broken by appropriately rotating a molecule in an 'optical centrifuge.'

References:

R.Hasbani, B.Ostojić, P.R.Bunker and M.Yu.Ivanov, Selective dissociation of the stronger bond in HCN using an optical centrifuge, *J. Chem. Phys.* **116**, 10636 (2002).

P.R.Bunker and Per Jensen, Chirality in rotational energy levels clusters, *J. Mol. Spectrosc.* in press.

ATTEMPTS TO EXPLAIN THE NATURE OF DARK ENERGY – HOW DESPERATE CAN WE GET?

Edmund COPELAND
University of Sussex, Brighton, UK

There appears to be growing evidence that our Universe is currently undergoing a period of accelerated expansion. It rises the intriguing, and for particle physicists, awkward question of what is supplying the energy density which could lead to such an evolution – the dark energy problem? An accelerating universe usually occurs when the dominant form of matter possesses a negative pressure. The most familiar form is a cosmological constant, and as the data improves it is looking more likely that there is an underlying extremely small cosmological constant dominating the energy density today. Why is it there? Why is it dominating now and why does it have a comparable contribution to the energy density as the dark matter?

I will try and introduce the observational evidence for dark energy, evidence which comes from a number of sources. High redshift supernova surveys, anisotropies in the cosmic microwave background and large scale structure surveys. I will then discuss attempts made in particle physics to explain the observed expansion and efforts to provide a formalism which would allow us to reconstruct the equation of state for the dark energy. These will range from: models motivated by string theory; postulating the existence of evolving scalar fields whose dynamics mimic that of a cosmological constant today; models which lead to an equation of state with $w<-1$, often known as phantom energy. In all cases, the need for fine tuning will be evident. The nature of this `Dark Energy' remains a puzzle for particle physics.

FROM ATOMS TO NANOPARTICLES: CHANGING THE SHAPE

Uroš V. DESNICA, Pavo DUBČEK, Maja BULJAN, Ida Dunja DESNICA-FRANKOVIĆ
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S. Bernstorff
Sincrotrone Trieste, Italy

Due to the large optical non-linearity as well as fast response times, composites containing II-VI binary semiconductor nanocrystallites in light-atom matrix show promise for very interesting applications in optical devices. CdS nanocrystals (NCs) were formed in various substrates by ion implantation, using high and equal doses of Cd and S atoms up to, $1x10^{17}$ cm^{-2}, and subsequent annealing up to T_a = 1000 ^oC. Fusion of atoms into CdS NCs within substrate, growth of the size of NCs, their size distribution, and the formation of 3D ensemble of NCs in the 200 nm thin implanted layer were tracked as a function of ion dose and T_a. The formation of CdS phase from constituent atoms was checked by several methods: low-angle-incidence X-ray Diffraction, Raman spectroscopy, UV-Visible Transmittance and Reflectance measurements. The shape of obtained CdS NCs, however, was strongly dependent on the choice of targeted substrate, selected in this work as either amorphous (SiO_2) or crystalline cubic (silicon) or crystalline hexagonal (γ-Al_2O_3).
The morphology of CdS NCs was studied by 2D grazing incidence small angle x-ray scattering (GISAXS), and Transmission Electron Microscopy (TEM). 2D GISAXS pattern comprised quasi-isotropic half-rings in SiO_2, elliptical half-rings in Al_2O_3, and streaks inclined under characteristic angles in silicon. The analyses of these patterns were performed using Guinier approximation as well as the local mono-disperse approximation (LMA). It was found that spherical NCs were formed in amorphous SiO_2 and elliptic, rod/like NCs in hexagonal Al_2O_3. In both types of samples a well correlated ensemble of NCs was distributed evenly in the implanted layer. In the Si substrate, however, the faceted, plate-like NCs of CdS are formed, nestled preferentially in the <111> planes of monocrystalline Si. The observed, very different self-organization of Cd and S-implanted ions into variously shaped and variously distributed CdS nanocrystals, depending of the target substrate, was analyzed in terms of minimizing total energy for the second phase formation and available space inside diverse substrate materials.

SMALL IS DIFFERENT: SIZE RELATED LUMINESCENCE

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Due to the quantum confinement effects, the II-VI-semiconductor nano-sized particles show intense size-dependent optical properties and strong visible luminescence. Thus, by changing the nano-crystal size, one gets fluorophores of different colors. In particular, CdSe nanocrystals cover most of the visible spectral range from the blue to the red. A promising route towards tailored nanophase materials is the intelligent exploitation of non-equilibrium processing techniques, like ion implantation, for synthesis of buried low-dimensional structures. We have studied CdSe nano-particles synthesized by ion-implanting constituent atoms in SiO_2, thermally grown on Si. The influence of implantation and post-implantation treatment parameters, with the emphasis on the less commonly studied influence of (non)stoichiometry, on the nucleation and growth of compound semiconductor nanocrystals, was investigated by Raman spectroscopy and small angle scattering of synchrotron radiation at grazing incidence (GISAXS), yielding the average size and size distributions of QDs, average inter-particle distance and distance distribution, as well as the fraction of implanted atoms which were synthesized into CdSe. These findings were related with PL intensities and the amount of well-crystallized CdSe QDs. Stoichiometry emerged as a very important parameter in optimizing PL properties, since it has a profound influence on the synthesis, size and spatial distribution of QDs as found by GISAXS.

INTRAMOLECULAR HYDROGEN BOND IN ACETYLACETONE: INFRARED SPECTROSCOPY AND TUNNELING DYNAMICS

Nadja DOŠLIĆ and Ivana MATANOVIĆ
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The portion of the potential energy surface (PES) of acetylacetone (ACAC) relevant for the intramolecular proton transfer reaction is analyzed using *ab initio* and DFT methods. Six stationary points on the PES were characterized as well at the reaction paths connecting these points. Our study reveals that the intramolecular proton transfer is not synchronized with the internal rotation of the distal methyl group.
The infrared spectrum of the O-H-O fragment of ACAC is studied using a four-dimensional model. This comprises the OH stretching, the in-plane OH bending and two O-O ring deformation modes. The full anharmonic PES and dipole moment surface are calculated using DFT/B1LYP. We have shown that the strong mode mixing in the OH stretching region which goes beyond the adiabatic two mode model[1], ν_{OH} and ν_{OO}, makes an assignment in terms of combination transitions impossible.
Further, the influence of the H-atom tunneling on the spectrum is treated by using large amplitude, symmetry adapted coordinates. The three-dimensional vibrational eigenvalue problem is solved by combining the generalized Fourier grid method[2] and an iterative Lanczos diagonalization. In ACAC the **G**-matrix elements vary markedly along the selected coordinates, and our best estimate of the tunneling splitting of 116 cm^{-1} is obtained by explicitly taking the $G_{sr}(\mathbf{q})$ coordinate dependence into account.

References:

1. O. Henri-Rousseau, P. Blaise, *Adv. Chem. Phys.* 103, 1 (1998).
2. J. Stare, G. G. Balint-Kurti, *J. Chem. Phys. A*, 107, 7204 (2003).

SQUEEZING LIGHT THROUGH SMALL HOLES: FUNDAMENTALS AND APPLICATIONS

Thomas W. EBBESEN
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The transmission of light through a subwavelength aperture, although conceptually very simple, is extremely difficult to describe theoretically. The various approaches that have been used all rely on a certain number of approximations to simplify the problem. The theory of Hans Bethe from 1944 is considered the key reference on this subject and it assumes that the aperture is in an infinitely thin and perfectly conducting metal film. In the real world, the aperture is made in a film of finite thickness and conductivity. The experimental studies being scarce, we have undertaken a detailed study of such single apertures in metal films that reveal that localized surface plasmons on the aperture ridge considerably modifies their transmission properties with respect to the theoretical predictions. As in the case of enhanced transmission through aperture surrounded by periodic corrugations, the surface plasmons modes concentrate the field at the aperture, thereby compensating for the inherently weak tunneling process through the aperture. The relation between the single aperture properties and surface plasmon enhanced transmission through hole arrays will be discussed.

These findings have broad fundamental and practical implications and show that, with modern fabrication techniques, surface plasmons can be engineered and controlled to yield unique optical properties which could find application in high density data storage, photonic integration, near field probes, etc..

References:

Ebbesen et al *Nature* **391**, 667 (1998); Martin-Moreno et al, PRL 86, 1114 (2001); Krishnan et al. *Optics Comm*. **200**, 1 (2001); Lezec et al, *Science* 197, 820 (2002); Martin-Moreno et al, PRL 90, 167401 (2003) ; Garcia-Vidal et al , *PRL* 90, 213901 (2003) ; Barnes et al, *Nature* **424**, 824 (2003), Barnes et al PRL 92, 107401 (2004) ; Degiron et al., *Optics Comm*. In press.

SYNTHESIS OF ORGANOMETALLIC COMPOUNDS UNDER HIGH PRESSURE

Mirjana ECKERT-MAKSIĆ, Davor MARGETIĆ and Srećko KIRIN
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High pressure synthesis[1] of novel policyclic structures containing silicon and germanium atoms placed at the bridgehead positions, (organometallic derivatives of bicyclo(2.2.1)hept-2-ene) will be presented. Thus, 1-sila-2,3,4,5-tetraphenyl-1,1-dimethyl-2,4-cyclopentadiene, 1-sila-2,5-diphenyl-1,1-dimethyl-2,4-cyclopentadienes and 1-germa-2,3,4,5-tetraphenyl-1,1-dimethyl-2,4-cyclopentadiene are used as reactive dienes, which readily undergo [4π+2π] cycloadditions with strained alkenes incorporated in norbornene skeleton (for instance, *anti*-1,4:5,8-diepoxy-1,4,5,8-tetrahydroanthracene was used as a dienophile) to give 7-silanorbornene or 7-germanorbornadiene derivatives.[2,3]

References:

1. Matsumoto, K.; Acheson, R. M. (eds.), *Organic Synthesis at High Pressures*, Wiley, New York, **1990**.
2. Kirin, S. I.; Eckert-Maksić. M. *Kem. Ind.* **1999**, *48*, 335.
3. Kirin. S. I.; Klärner, F.-G.; Eckert-Maksić. M. *Synlett* **1999**, 351.

SPECTROSCOPY OF COLD Cs_2 MOLECULES ON HELIUM NANODROPLETS

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In recent years, experiments with alkali doped helium nanodroplets1 have shown that alkali metal atoms remain on the helium surface where they "skate" around and form molecules in cold collisions. The molecular binding energy is absorbed by the helium environment, which leads to evaporation of helium atoms until the cluster temperature has re-equilibrated to 0.4 K, the internal temperature of a stable helium nanodroplet. In a helium nanodroplet beam experiment, droplets with a newly formed van der Waals molecule survive whereas those with tightly bound reaction products "on board" evaporate and do not reach the measurement zone. This selectivity has helped to study a number of alkali dimer triplet states through direct excitation from the lowest $^3\Sigma_u^+$ state that is formed in collisions of two atoms on the surface of a helium nanodroplet [1]. Many studies have focused on the lighter alkali species Li, Na, and K. First experiments with rubidium and helium showed a large abundance of molecular rubidium spectra [2] the analysis of which should be accompanied by theoretical calculations of potentials of sufficient accuracy. Excitation spectra of cesium molecules adsorbed on the surface of cold helium nanodroplets were measured over a broad frequency range. In our theoretical analysis of these spectra we have used ab-initio potential curves by Spies and Meyer [3]. These theoretical potential curves when used in the simulation of cesium spectra exhibited satisfactory agreement with experimental spectra at thermal conditions [4]. Preliminary analysis of the new cesium spectra on helium points to some very interesting coincidences of experimental and theoretical spectra. However, there are some open questions regarding the possible role of symmetry-breaking processes.

THE STARK ACCELERATOR/DECELERATOR VIEWED AS A BIASED PENDULUM

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Stark deceleration, along with buffer-gas cooling and photoassociation of cold atoms, ushered in the era of the ultra-cold in molecular physics. Stark decelerators (or accelerators) of polar molecules bear similarity with charged-particle accelerators used over the past 60 years in particle physics. However, since molecules possess states whose eigenenergy can both increase and decrease with the strength of the field they are subjected to, and since both acceleration and deceleration are of interest, the molecular case calls for a more general approach than the one which was adequate for the understanding of acceleration of charged particles.

The Stark accelerator/decelerator relies on time-dependent inhomogeneous electric fields. So far, these have been generated by linear switchable field arrays. First I Fourier-analyze the field produced by such a field array. This analysis reveals that the field consists of a number of partial waves traveling at distinct phase vlocities.

Next I describe the kinematics of the field-molecule interaction and introduce the notion of a phase of a molecule in a traveling periodic accelerator/decelerator field. Then I introduce the Stark potential and force that act on a molecule and derive the molecule's equations of motion, both in terms of the laboratory-fixed coordinates and of the phase with respect to the traveling field. Then I discuss a special case of a Stark accelerator/decelerator, the first-harmonic accelerator/decelerator, whose equation of motion is isomorphic with that of a biased pendulum. Since the biased pendulum problem can be solved analytically (this will be shown in an interlude), valuable lessons about the accelerator/decelerator can be drawn from it. The dynamics of a first-harmonic accelerator/decelerator or, interchangeably, of a biased pendulum, will be subsequently presented and discussed in terms of phase diagrams. Finally, I'll consider the general properties of the velocity of the molecules in a phase-stable accelerator/decelerator. These properties reveal that the Stark accelerator/decelerator behaves like a flying accordion.

OPTIMAL CONTROL OF MOLECULAR AND ELECTRON DYNAMICS BY TAILORED FEMTOSECOND LASER PULSES

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Obtaining active control over the dynamics of quantum-mechanical systems is a fascinating perspective in modern physics [1]. The approach of adaptive femtosecond quantum control follows the suggestion of Judson and Rabitz [2], in which a computer-controlled pulse shaper is used in combination with a learning algorithm [3] and direct feedback from the experiment to achieve coherent control over quantum-mechanical processes in an automated fashion, without requiring any model for the system's response. Laser-optimized femtochemistry in the gas phase and liquid phase is one field in which this new technique is successfully employed. Automated optimization of branching ratios and total product yields of gas phase photodissociation reactions as well as chemically selective molecular excitation in the liquid phase is performed [4] [5].

A central question in chemistry and biophysics is how the structure and the dynamics of complex molecules evolve and are related to the primary processes. Structural changes of a molecule in the liquid phase have been induced by laser-optimized switching between the trans- and the cis-configuration in the photoisomerization of a cyanine dye molecule [6].

A new technological development further increases the possibilities and prospects of quantum control. With the technique of femtosecond polarization pulse shaping [7], it is now possible to vary intensity, momentary frequency, and light polarization (i.e., the degree of ellipticity as well as the orientation of the principal axes) as functions of time within a single femtosecond laser pulse. The time dependent variation of the polarization state of an ultrashort laser pulse has been used to optimize multiphoton ionization of dimer molecules K_2 from a cold molecular beam [8]. This experiment demonstrates a qualitative extension of quantum control mechanisms.

Adaptive high-harmonic XUV spectral shaping is performed by phase-only shaping of the fundamental (800 nm) driver laser pulse. A high degree of control is observed. Enhancement of single harmonics or group of harmonics as well as creation of spectral holes in the plateau region, i.e. suppression of particular harmonics, is achieved. Automated spectral shaping opens the door to XUV sub-femtosecond temporal pulse shaping [9]. Due to the universality of computer-controlled learning optimization of ultrashort laser pulses, a broad field of applications opens up in all areas which use femtosecond laser technology, such as in physics (i.e high harmonic generation), chemistry, biology (multiphoton microscopy), or material sciences (ablation optimization).

References:

[1] T. Brixner, N.H. Damrauer, G. Gerber, In „Adv. in At., Mol. and Opt. Phys.", Vol. **46**, pp. 1-54, Academic Press (2001); T. Brixner, G. Gerber, Chem. Phys. Chem. **4**, 418-438 (2003)

[2] R. S. Judson and H. Rabitz, Phys. Rev. Lett. **68**, 1500 (1992)

[3] T. Baumert, T. Brixner, V. Seyfried, M. Strehle, and G. Gerber, Appl. Phys. B **65**, 779 (1997)

[4] A. Assion, T. Baumert, M. Bergt, T. Brixner, B. Kiefer, V. Seyfried, M. Strehle, G. Gerber, Science **282**, 919(1998); T. Brixner, N. H. Damrauer, G. Krampert, P. Niklaus, G. Gerber, J. Mod. Opt. **50**, 539 (2003)

[5] T. Brixner, N. H. Damrauer, P. Niklaus, and G. Gerber, Nature, Vol. **414**, 57 (2001); T. Brixner, N. H. Damrauer B. Kiefer, and G. Gerber, J. Chem. Phys. 118, 3692 (2003)

[6] G. Krampert, P. Niklaus, G. Vogt and G. Gerber, Nature (2004)

[7] T. Brixner and G. Gerber, Opt. Lett. **26**, 557 (2001)
T. Brixner, G. Krampert, P. Niklaus, G. Gerber, Appl. Phys. B **74**, S133 (2002)

[8] T. Brixner et al, Phys. Rev. Lett. **92**,208301 (2004)

[9] T. Pfeifer, D. Walter, C. Winterfeldt, C. Spielmann, G. Gerber – to be published –

FROM ULTRA-PRECISE SPECTROSCOPY TO ATTOSECOND PHYSICS

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Femtosecond laser frequency comb synthesizers have become revolutionary tools for measuring the frequency of light. Applications include optical atomic clocks, ultraprecise laser spectroscopy, and fundamental tests such as searches for time variations of fundamental constants. Frequency comb techniques can also control the carrier-envelope phase of ultrashort laser pulses, revealing novel phenomena in nonlinear light-matter interactions.

SUMMARY OF THE CONFERENCE

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I will attempt to summarize the thrust of the talks on extreme conditions in Nature. My purpose will be to to discern how these different extremes can be understood in terms of overarching physical theory, as we understand it today. Unless we obtain insight into extreme conditions, where a single factor may predominantly determine the characteristics of a phenomenon, we will be unable to make headway on explaining more normal conditions, which often involve a complex confluence of many competing forces.

MATERIALS UNDER PRESSURE: NEW FINDINGS AND PHENOMENA

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Recent developments in high-pressure techniques are leading to new insights about the behavior of materials under extreme conditions. Experiments based on diamond or gem anvil technology permit an increasing array of measurements techniques in situ on materials subjected to pressures of >300 GPa and variable temperatures from cryogenic conditions to thousands of kelvins. Examples of intriguing phenomena include transitions in hydrogen, related diatomic molecules, and polyatomic systems; novel bonding properties in mixtures of these simple molecular systems; pressure-induced metallization and superconductivity, including the creation of new superconductors; structural, electronic, and magnetic transitions in metals and oxides; and unexpected findings in soft matter and biological systems. These findings have been made possible in large measure by accelerating developments in synchrotron radiation techniques for diffraction, spectroscopy, and inelastic scattering. These advances are complemented new high-pressure neutron scattering, electrical transport, and magnetic methods. Finally, advances in single crystal CVD diamond will make possible new classes of high-pressure measurements.

MANIPULATION OF BEC AND DEGENERATE FERMI GASES WITH LASER LIGHT

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Ultracold bosonic (87Rb) and fermionic (40K) atomic gases are produced by means of laser, evaporative and sympathetic cooling. Experiments are performed by combining the quantum degenerate gases with optical potentials created by light waves. The observed phenomenology includes the role of collisions in the transport properties through an optical lattice, the instability in the dynamic of a BEC and the interferometry with trapped particles.

SPECTROSCOPY OF (HELIUM)$_N$-MOLECULE CLUSTERS: TRACING THE ONSET OF SUPERFLUIDITY

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High resolution molecular spectroscopy holds great promise to bridge the gap in our knowledge about microscopic, molecular-scale systems on one side and the bulk phase on the other. Spectroscopy of weakly bound complexes has recently been pushed into the mesoscopic size regime with the investigation of medium-sized He$_N$-molecule clusters. The successive solvation of molecular chromophores with helium atoms promises to shed light on the microscopic evolution of the bulk phase property superfluidity. The evolution of the cluster moments-of-inertia as function of N, the number of helium atoms, shows that the helium atoms begin to decouple from the rotational motion of the monomers. It will be explored how the trends in the spectroscopic constants of the quantum solvated systems can be used to trace the onset of the new property of 'microscopic superfluidity'.

FROM CHEMICAL TOPOLOGY TO MACHINES AND MOTORS AT THE MOLECULAR LEVEL

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Catenanes (interlocking rings) and **knots** represent attractive synthetic challenges for molecular chemists. Besides their topological properties, these systems can be regarded as works of art at the nanometer scale. The creation of such complex molecules also demonstrates that synthetic chemistry is now powerful enough to tackle problems whose complexity is sometimes reminiscent of biology, although the elaboration of molecular ensembles displaying properties as complex as biological assemblies is still a long-term challenge.

The field of artificial molecular machines and motors has experienced a spectacular development in the course of the last decade, in relation with biological motors (as mimics) or information storage and processing at the molecular level (toward molecule-based computers). These systems are multicomponent assemblies undergoing large-amplitude geometrical changes or leading to the locomotion of one of the components, under the action of an external stimulus.

Threaded or interlocking rings are ideally suited to the construction of fully artificial molecular motors. If a ring is threaded onto a rod, it can either rotate around the axle or undergo a translation movement. Similarly, in catenanes, a ring can glide at will and spin within another ring.

Several examples or such compounds have been elaborated and studied in recent years. In particular, our group has proposed several molecular assemblies acting as "machines". They are based on transition metal complexes and the systems are set in motion by sending an electrochemical, a photochemical or a chemical signal. A recent contribution describes a doubly threaded compound which can be contracted or stretched at will. It is thus reminiscent of skeletal muscles. Another approach is based on dissociative excited states such as the ligand-field state of $Ru(bipy)_3^{2+}$ derivatives. New rotaxanes (rings threaded by a molecular axis) and catenanes have been constructed around an octahedral centre (Ru). These systems can be set in motion by sending a photonic signal to the molecule.

In a long-term prospective, the field may find applications in relation to information storage and processing at the molecular level. It can also be envisaged that microrobots be built, using molecular components able to move the various parts of an articulated backbone.

GAS-PHASE REACTION OF Nb+ and Fe+ WITH PERFLUORONAPHTALENE AND PERFLUOROANTHRACENE[#]

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We investigate the gas-phase reaction of Nb^+ and Fe^+ ions with perfluoronaphthalene and perfluoroanthracene compounds. The perfluoro effect shifts the σ-orbitals of these compounds to higher ionization energies and, as a result, they exhibit several outer-valence-ring π-orbitals. It might be expected that reactions with these compounds will proceed mostly through π-interaction between the metal and PAH orbitals. Surprisingly, as we will see, this is not the case. Fe^+ reacts with perfluoronaphthalene (**NF8**) and perfluoroanthracene (**AF10**) by successive addition and (sandwich) dimer formation. Nb^+, however, reacts by extraction of F atoms, preferably 4, followed by the formation of dimers that do not contain any metal atoms. The structure of this abundant ionic product **AF6** is elucidated by quantum chemical calculations.

Dedicated to the memory of Dr. Franjo Kajfež, a great Croatian medicinal chemist, who passed away on April 23, 2004.

MAKING AND BREAKING WEAK BONDS: SPECTROSCOPIC STUDIES OF INTERMOLECULAR INTERACTIONS

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We discuss structure and dynamics of molecular complexes. The topics include the dependence of vibrational predissociation of hydride complexes upon valence and soft mode excitation level as well as the dependence of the configuration of minimum energy upon valence excitation. The non-rigidity as well as non-classical dynamics, as evidenced by strong isotopic dependences will also be discussed. The large body of spectroscopic data that exist for molecular complexes allows comparisons with long time models as well as relatively sophisticated electron structure calculations. The research is by Drs. Kelly Higgins and Zhenhong Yu, and Mr. Patrick Medley and is made possible by the support of the National Science Foundation.

SMALL HYDRIDE MOLECULES IN LASER VAPORIZED PLUME

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Hydrogen is the main constituent of the Universe. Beside atomic and molecular hydrogen, many other molecules containing hydrogen were identified in interstellar medium and stellar atmospheres [1]. A lot of hydrides spectroscopic data are still missing. Laboratory conditions are far from conditions in, for example, stellar atmospheres where hydrides were observed. To study simple hydride molecules spectroscopically, one needs to find efficient production method. One possible way is laser vaporization of carefully prepared solid targets. Molecules can be vaporized directly from the target surface or through numerous interactions between vaporized particles and background gas. Laser vaporization can circumvents usage of different high-temperature ovens. Previously, we showed that alkali molecules emerging directly from target surface were rotationaly and vibrationaly cold [2]. In this work we focus on the laser vaporization of pure manganese target and $LiAlH_4$ complex target. Laser induced plume was studied by the cavity ring-down spectroscopy (CRDS) and time-resolved emission measurements. We studied dynamics of the vaporized plume and measured velocities of atoms and molecules. Molecules were not visible in the emission spectra of vaporized plume, while absorption measurements by CRDS resulted with rich molecular ro-vibrational bands. By CRDS, we observed several MnH($a^4\Sigma^+$ - $d^5\Pi$) ro-vibrational bands within the electronic $a^4\Sigma^+$ - $d^5\Pi$ transition in the pure manganese vaporization plume spreading into CH_4 atmosphere. MnH molecules were formed in reaction with methane and its dissociation products, CH_n, n = 1...4. In vaporization plume of the $LiAlH_4$ target, AlH (0,0) ro-vibrational band within the $X^1\Sigma^+$ - $A^1\Pi$ electronic transition was observed. From measured ro-vibrational line-positions we calculated rotational constants for the $X^1\Sigma^+$ and $A^1\Pi$ electronic states.
These results encourage us in searching for other simple hydrides, like LiH, in laser vaporization experiments.

References:

[1] J. Tennyson, *Molecules in Space* in Handbook of Molecular Physics and Quantum Chemistry Vol. 3, Ch.14, Wiley&Sons, Chichester, 2003
[2] I. Labazan, S. Milošević, Phys. Rev. A **68** (2003) 032901

MAGNETICALLY CONFINED THERMONUCLEAR GRADE PLASMAS

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The terrestrial realization of a continuous, self-sustaining thermonuclear fusion requires the confinement and the thermal insulation of a 200 Million K plasma with a volume in excess of 1000 m^3 and a pressure of the order of 10 atm. In smaller volumes (about 100 m^3) significantly higher temperatures (about 400 Million K) have already been reached. This involves the solution of challenging technological problems (high energy, partly pulsed superconducting magnet systems, handling of steady state power fluxes in excess of 10 MW/m^2, remote performance of maintenance and repairs). In spite of the well-understood elementary processes involved, the realisation poses, however, also challenging physics issues. The complexity of the latter is driven essentially by the spread of time-and space-scales of the governing processes whose simultaneous interaction has to be considered. Before the onset of thermonuclear burn the plasma behaviour is governed by three independent dimensionless parameters: ρ^* (the ratio of gyro-radius to device size), ν^* (collision frequency / particle transit frequency) and β (plasma pressure/magentic field pressure). We initially describe the particular, non-local thermodynamic equilibrium establishing itself in such a plasma, and concentrate afterwards on two particularly salient aspects of its dynamics: (1) the gradient driven turbulence determining the energy losses, including the self-organisation of temperature, density and rotation profiles and the spontaneous formation of transport barriers, and (2) the expected consequences of thermonuclear heating, which proceeds via the thermalisation of the magnetically confined 3.5 MeV α-particles. Due to their high birth velocity these particles can resonate with propagating global Alfven waves, feeding energy into them, however, not through relaxation of their velocity distribution, but through their spatial density gradients.
Finally we show how these and other physics and technology issues determined the lay-out and the research program of the planned international burning plasma device ITER.

SMALL IS DIFFERENT: SELF-SELECTION, SELF-ORGANIZATION AND SYMMETRY BREAKING AT THE NANO-SCALE AND UNDER EXTREME CONFINEMENT

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At sufficiently small sizes the properties of materials are commonly observed to depend on size. Such dependencies may go beyond mere scaling with size, manifesting themselves in physical and chemical behaviour that is *new and different* from that found at larger sizes. Such circumstances, when *small is different in an essential way*, may occur when one (or more) of the physical dimensions of the material aggregate approaches a length-scale characteristic to a physical phenomenon (with different phenomena being characterized by different length-scales). Basic research of these and related issues underlies future technologies, and it requires the development of new theoretical and experimental approaches. These physical and methodological issues will be discussed and illustrated using results obtained through "computational microscopies" – that is, large-scale classical and quantum simulations.

Topics will include: Generation, stability and breakup of nanostructures – atomistic and stochastic hydrodynamical simulations of nanojets exploring the limit of validity of continuum approaches, and cluster-deposited fractal islands; Spontaneous symmetry breaking leading to formation of crystallized electronic clusters (Wigner molecules) in two-dimensional quantum dots, and consequences for the fractional quantum Hall effect; Emergence of magnetism in free and surface-supported small palladium clusters; Counter-ion- gated polaronic charge transport in ionized DNA, and rheological and nanotribological properties of lubricating fluids in highly confined environments.

ARE LOCAL AND 1 KPC DISTANT COSMIC BACKGROUND RADIATION TEMPERATURES THE SAME?

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The most accurate determination of the Cosmic Background Radiation (CBR) temperature T_γ has been carried out by the orbiting observatory Cosmic Radiation Explorer (COBE), which therefore measures its local value at about 1 AU from the Sun. Measurement of the CBR temperature T_γ(CN) from interstellar CN absorption provides values of T_γ in several clouds within 1 kpc. Published data on interstellar CN absorption shows that T_γ(CN) is slightly greater than the standard cosmological CBR temperature, T_γ(COBE) = 2.725 ± 0.001 K, determined by the COBE satellite, even when the effects of local excitation of CN, mainly by electron collisions, are taken into account. One way of dealing with this discrepancy is to consider whether the local and distant values of T_γ could be different. If one discounts this possibility then other factors must be considered. A source of possible error, not previously considered, in the determination of T_γ(CN) from interstellar CN absorption is proposed. This concerns the intrinsic assumption of the validity of using Hönl-London rotational line intensity factors to determine the rotational components of the oscillator strengths of the CN $B^2\Sigma^+ - X^2\Sigma^+$ (0,0) band R(0), R(1) and P(1) lines. The difference between the T_γ(COBE) and T_γ(CN) values are used to estimate the maximum corrections, a few percent, to the ratio of the line strengths and to the ratio of the Hönl-London factors. Fluorescence lifetime data are shown to give similar values for the corrections as well as providing evidence for intramolecular coupling between the relevant $B^2\Sigma^+$ state rotational levels and close-lying levels of the $A^2\Pi$ state, this being responsible for rendering the standard Hönl-London factors invalid [1].

References:

[1] S.Leach, *Can.J.Chem.*, in press (2004, special memorial issue for Gerhard Herzberg).

CASSCF/CASPT2 STUDY OF MECHANISM AND KINETICS OF THE GAS - PHASE OZONE ADDITIONS TO ETHENE, FLUOROETHENE AND CHLOROETHENE

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Studies into reactivity of ozone towards ethene and its monohalogenated derivatives play an important role in evaluating the persistance of these widespread class of pollutants in the troposphere. Multiconfigurational CASSCF and multireference CASPT2 quantum-chemical methods were used in studying mechanism and kinetics of the gas-phase ozone additions to ethene, fluoroethene and chloroethene. Geometrical structures and harmonic vibrational wavenumbers of the reactants, transition states and products were calculated at the CASSCF/cc-pVTZ level of theory. All the electron energies were further refined at the CASPT2/cc-pVTZ level with the optimized CASSCF wave functions taken as the zeroth order. The rate constants and Arrhenius kinetic parametres were then calculated in terms of the conventional transition state theory (C-TST). The overall reliability of the CASPT2 approach was tested by performing a numerical calculation of the equlibrium geometry, harmonic vibrational wavenumbers and force field of the ground state ozone. Use of the Dunning's correlation consistent basis sets enabled a two-point extrapolation of the examined properties to the limit of infinite basis. The mechanism of ozonolyses includes formation of the primary addition products, their decomposition and possible re-arrangement to the secondary addition products in condensed phase. Also studied was the unimolecular decomposition of (halo)carbonyl oxides, ozonolytic fragments relevant to the processes in the atmosphere.

QUANTUM HORIZONS AND SPACETIME NON-COMMUTATIVITY

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In standard General Relativity without Quantum Mechanics (QM) a fundamental instability against collapse implies the existence of black holes as stable solutions of Einstein's equations. The QM and the Quantum Field Theory (QFT) in the curved spacetime with classical event horizon are troubled by the singularity at the horizon. This problem may be solved by treating the black hole as a quantum state which implies that the energy of the black hole and its corresponding time do not commute at the horizon. In this picture we study the dynamics of a scalar field in the near-horizon region described by a static Klein-Gordon operator which is the Hamiltonian of the system. The explicite construction of the time operator near-horizon is given and its self-adjointness discussed.

MANIPULATION OF MOLECULES WITH ELECTRIC FIELDS

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During the last years we have been experimentally exploring the possibilities of manipulating neutral polar molecules with electric fields [1]. Arrays of time-varying, inhomogeneous electric fields have been used to reduce in a stepwise fashion the forward velocity of molecules in a beam. With this so-called 'Stark decelerator', the equivalent of a LINear ACcelerator (LINAC) for charged particles, one can transfer the high phase-space density that is present in the moving frame of a pulsed molecular beam to a reference frame at any desired velocity; molecular beams with a computer-controlled (calibrated) velocity and with a narrow velocity distribution, corresponding to sub-mK longitudinal temperatures, can be produced. These decelerated beams offer new possibilities for collision studies, for instance, and enable spectroscopic studies with an improved spectral resolution; first proof-of-principle high-resolution spectroscopic studies have been performed. These decelerated beams have also been used to load neutral ammonia molecules in an electrostatic trap at a density of (better than) 10^7 mol/cm^3 and at temperatures of around 25 mK. In another experiment, a decelerated beam of ammonia molecules is injected in an electrostatic storage ring. The package of molecules in the ring can be observed for more than 50 distinct round trips, corresponding to 40 meter in circular orbit and almost 0.5 sec. storage time, sufficiently long for a first investigation of its transversal motion in the ring. A scaled up version of the Stark-decelerator and molecular beam machine has just become operational, and has been used to produce trapped samples of ground-state OH radicals and decelerated beams of electronically excited (metastable) NH radicals. The NH radical is particularly interesting, as an optical pumping scheme enables the accumulation of decelerated bunches of slow NH molecules, either in a magnetic or in an optical trap. By miniaturizing the electrode geometries, high electric fields can be produced using only modest voltages. A micro-structured mirror for neutral molecules that can rapidly be switched on and off has been constructed and used to retro-reflect a beam of ammonia molecules with a forward velocity of about 30 m/s. This holds great promise for miniaturizing the whole decelerator, trap and storage ring for future applications.

References:

[1] H.L. Bethlem and G. Meijer, *Int. Rev. Phys. Chem.* 22, 73 (2003)

CHARGE AND ISOSPIN FLUCTUATIONS IN HIGH ENERGY PP-COLLISIONS

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Charge and isospin event-by-event fluctuations in high-energy pp-collisions are predicted within the Unitary Eikonal Model (**UEM**), in particular the fluctuation patterns of the ratios of charged-to-charged and neutral-to-charged pions. These fluctuations are found to be sensitive to the presence of unstable resonances, such as ρ and ω mesons. In the frame of UEM model we found that the charge-fluctuation observable $\mathbf{D}_{\mathrm{UEM}}$ should be restricted to the interval $\mathbf{8/3 < D_{UEM} < 4}$ depending on the ρ/π production ratio.

References:

1. S. Jeon and V. Koch, *Phys. Rev. Lett.* 83 (1999) 5435; 85 (2000) 2076; M. Bleicher, S. Jeon and V. Koch, *Phys. Rev. C* 62 (2000) 061902.
2. M. Martinis, V. Mikuta-Martinis, A. Švarc and J. Črnugelj, *Fizika B* 3 (1994) 197; M. Martinis, V. Mikuta-Martinis, A. Švarc and J. Črnugelj, *Phys. Rev. D* 51 (1995) 2482; M. Martinis, V. Mikuta-Martinis and J. Črnugelj, *Phys. Rev. C* 52 (1995) 1073.
3. C. Blume, NA49 coll., *Nucl.Phys.* A698,(2002) 104c.
4. CERES coll., J. Stachel, contribution to 2002 Epiphany Conf., Cracow, January 2002 (to be published in *Acta Phys. Pol. B*).

EXTREMES OF LIFE ON EARTH: CAN THEY TELL US ABOUT THE POSSIBILITY OF LIFE ELSEWHERE?

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In the past two decades, our view of life on our own planet has been dramatically altered, with the discovery and characterization of "extremophiles" – those organisms, primarily simple single celled prokaryotes, that not only survive, but thrive in, conditions generally regarded as toxic to life. These include extremes of temperature, pressure, pH, salinity, dryness, radiation, and nutrition. These revelations have served to enlarge our view of the relationship between life and environmental conditions. To some degree it has redefined what has been called the "habitable zone". It has also broadened our horizons in the sense that if carbon based life can adapt to virtually any condition our own planet offers, how far can it go? Understanding the mechanisms by which life adapts to these various extremes allow us to define life in new terms and to formulate a plan for searching for life, one based primarily on physics, chemistry, and informatics. This view of non-earthcentric life detection will be discussed, with an emphasis on the survival (and propagation) of organic matter.

EVOLUTION OF PULSED ALKALI DISCHARGE LAMPS SPECTRA

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We present new time resolved spectral measurements with pulsed high-pressure cesium and sodium discharge lamps, which are sources of white or nearly white light. The use of simple OceanOptics digital spectrometers the spectra from 200 to 1100 nm have been obtained in several different experimental conditions. The time evolution of spectra of cesium and sodium discharge lamps will be shown from the ignition to the full power of the light intensity. In addition, spectra at different times within a single pulse will be presented, in order to better distinguish atomic from molecular features.

The goal of a present research is to analyze spectra within 200-1100 nm spectral region, in order to find better composition of alkali elements for the further development of pulsed high-pressure alkali discharge plasmas.

In addition, we shall present new infrared spectra within 1000-2000 nm spectral range, where numerous atomic and molecular phenomena can be now explained using recent ab initio calculations of both atomic structure and molecular potential curves.

References:

[1] G. Pichler, V. Živčec, R. Beuc, Ž. Mrzljak, T. Ban, H. Skenderović, K. Günther and J. Liu, *Physica Scripta*, **T105** (2003) 98.

[2] H.Gu, M.E.Muzeroll, J.C. Chamberlain and J.Maya, Plasma Sources Sci. Technol. **10** (2001) 1.

ENTANGLED MATTER

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Entanglement is considered as the most profound feature of quantum mechanics but has been recently demonstrated for material objects containing billions of atoms. Entangled states are extremely fragile and require ultimately quiet environment to survive. Nonetheless it turned out that two large objects can stay entangled for up to a millisecond. Such entangled state can be used for quantum information processing, for example, for quantum memory for light and quantum teleportation.

ON CANONICAL LABELING OF PROTEOME MAPS

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We propose a canonical labelling of proteome maps, which facilitates sorting and cataloguing of the maps as well as comparison of the maps originating from different laboratories. The canonical label of a proteome map is based on the canonical labelling of vertices of hierarchical diagram embedded in the map that results in the adjacency matrix the rows of which thought as binary numbers are the smallest possible. The use of the approach in documentation is illustrated with the proteome maps of liver cells of healthy male Fisher F344 rats and the rats treated with different peroxisome proliferators.

HELICAL STRUCTURES IN PHYSICS AND BIOLOGY: FROM ATOMS ADSORBED ON CARBON NANOTUBES TO MICROTUBULES AND PINEAPPLES.

Antonio ŠIBER
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I will show that the typical helical order present in biological nanometric structures, such as tobacco mosaic virus and microtubule, can be obtained in a "familiar" equilibrium thermodynamics context. Namely, the same order appears in long-range ordered physisorbed overlayers on carbon nanotubes. [1]

References:

[1] A. Siber, Phys. Rev. B 68, 033406 (2003)

HIGH-ENERGY-DENSITY SCIENCE ON THE NATIONAL IGNITION FACILITY

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Inertial fusion and high-energy density researchers world-wide are planning experiments on a number of new facilities that can reach unprecedented temperatures, pressures, and densities. These facilities include pulsed power Z-pinch machines, large multi-beam laser systems, and high-power, short-pulse laser systems. In the United States, the National Ignition Facility (NIF), currently under construction at the University of California's Lawrence Livermore National Laboratory has completed the activation and commissioning of its first four laser beams. NIF is a $2.25B football stadium-sized laser and experimental facility that when completed in 2008 will contain a 192-beam, 1.8-Megajoule, 500-Terawatt, 351-nm laser system. With the completion of the first four beam, NIF has already established itself as the world's most energetic laser system and has demonstrated key laser system performance requirements. The first physics experiments have already been fielded on NIF studying laser-plasma interactions and hydrodynamics. Other experiments are planned to study materials equation of state and strength. After NIF is completed it will provide a national center for researchers to study inertial confinement fusion and the physics of extreme energy densities and pressures.

Fusion ignition research on NIF will use up to 192 energetic laser beams to compress small fusion targets to conditions where they will ignite and burn, liberating more energy than is required to initiate the fusion reactions. NIF experiments will allow the study of physical processes at temperatures approaching 100 million K and 100 billion times atmospheric pressure. These conditions exist naturally only in the interior of stars and in nuclear weapons explosions.

This presentation will discuss the NIF laser system including enhancements to NIF's capabilities to provide picosecond laser pulses for high-energy x-ray radiography and ultimately for fast ignition studies. First results from experiments on NIF will be presented along with plans for additional diagnostics and experimental platforms.

NIF is being built by the University of California, Lawrence Livermore National Laboratory under the auspices of the U.S. Department of Energy and the National Nuclear Security Agency under contract W-7405-Eng-48.

CHANGING ENZYME SPECIFICITY

Sanja TOMIĆ
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I will present the enzyme problem in general, give a few examples of diseases correlated with (inadequate) specificity of enzymes, introduce lipases as enzymes that stereoselectively catalyse reactions, stress importance of such catalysis for production of drugs, explain how stereoselectivity could be changed (and reversed), and how we approach this problem by molecular modeling.

COSMIC PROBLEMS FOR CONDENSED MATTER EXPERIMENT

Tanmay VACHASPATI
Case Western Reserve University, Cleveland, USA

Condensed matter analogs of the cosmological environment have raised the hope that laboratory experiments can be done to test theoretical ideas in cosmology. I will describe Unruh's sonic analog of a black hole (‘dumbhole’) that can be used to test Hawking radiation, and some recent proposals on how one might be able to create a dumbhole in the lab. In this context, I also discuss an experiment already done on the Helium-3 AB system by the Lancaster group.

AB INITIO AND SPECTROSCOPIC STUDIES OF CHIRAL INTERACTIONS

Yunjie XU, Zheng SU, and Waishun TAM
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We use laser spectroscopic and ab initio computational methods to study the phenomena of chirality and chiral discrimination on the molecular level. A detailed ab initio study of the weakly bound complex between two chiral molecules, i.e. propyleneimine and hydrogen peroxide, will be presented. A mid-infrared cavity ring-down spectrometer with supersonic expansion is under construction in our laboratory. The non-invasive, very low temperature environment of a pulsed expansion provides an ideal 'laboratory' to prepare these chiral diastereomers and to detect the subtle spectroscopic features that are caused by chiral discrimination. Preliminary experimental results from the cavity ring-down spectroscopic investigation will be presented.

QUANTUM COMPUTING AND QUANTUM COMMUNICATION WITH QUANTUM OPTICAL SYSTEMS

Peter ZOLLER
University of Innsbruck, Austria

We discuss theoretical concepts and methods of implementing quantum computing and quantum communication with quantum optical systems. The specific model systems of interest are trapped ions, atoms in optical lattices and atomic ensembles. We show how to prepare these systems, and how to realize quantum gate operations. The main part of the talk will focus in recent work with quantum degenerate atoms in optical lattices. In particular, we will discuss a recent proposal to build a single atom transistor, and its applications e.g. in spectroscopcy of many atom systems, as well as several new ideas for loading large arrays of qubits in optical lattices and healing defects.

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